Electronics and Software Engineer for Robotics Project Intern

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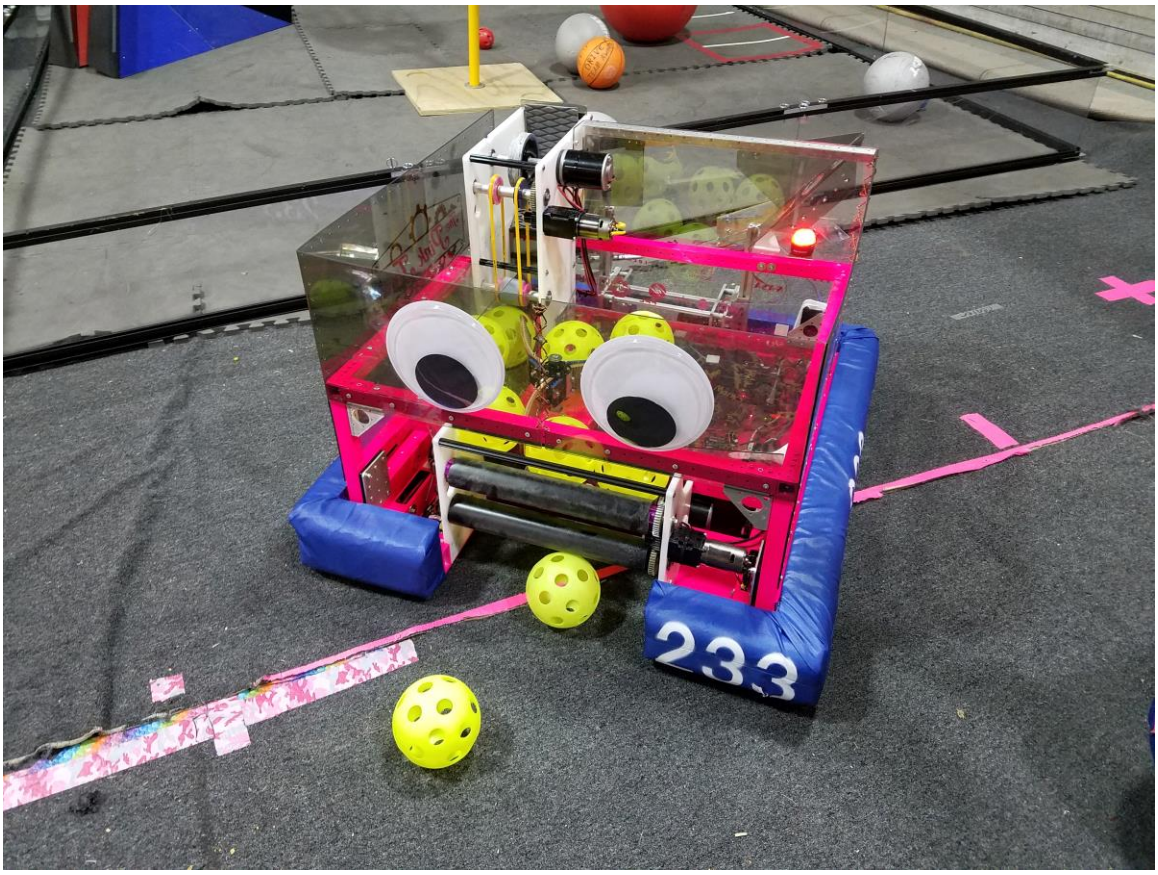

I was assigned to mentor high school students for the 2017 First Robotics Competition. Using a team based approach, I worked with the students to program the robot and applied my electrical background to build the robot from start to finish. I worked with students who had an interest in electrical engineering to teach them about voltage, current, pulse width modulation, solenoids, electromagnets, relays, DC motors, DC motor controllers, crimping and soldering electrical components, Java programming, and robotic simulation. For the simulation, we worked together to generate graphics files, write simulator description format code, operate Linux, and operate SOLIDWORKS. Upon completion of the FRC season, I transitioned over to providing full time support for the LCS hardware team. During this phase of my internship I helped my co-intern write test steps for two networking hardware DVTs , as well as run cables and update cable running lists.

Nomenclature

FRC = First Robotics Competition
CAD = Computer Aided Design
LCS = Launch Control Systems
DVT = Design Verification Test
SCCS = Spaceport Command and Control System

I. Introduction

The First Robotics competition is a challenging nationwide competition between thousands of teams across the globe that requires well-rounded people to mentor high school students to build a robot that satisfies a number of requirements. This year's competition revolved around a steam powered airship theme. Teams were required to build a robot that could collect and deposit fuel (the fuel was represented by wiffle balls) for the airship, collect and deposit gears to enable the airship's rotors to spin, and at the end of the match to climb a 5 foot rope in order to board the airship for takeoff. The team whose airship was best configured for takeoff won the match. In participating in the First Robotics Competition, the Kennedy Space Center gives high school students the opportunity to work side-by-side with exceptional mentors to create a complex robot. This experience hopefully influences the students to pursue STEM careers.

Once the competition season ended, I spent my time providing support to the LCS hardware team to sustain the network design of the SCCS project. Prior to this internship I had little networking experience. In being allowed to jump in on this project, I have been afforded a phenomenal opportunity to learn networking from the ground-up. The SCCS will be responsible for the launch of NASA's next-generation launch vehicle, and by contributing to it I am doing work I can be proud of for the rest of my life.

II. Approach

The First Robotics Competition required me to learn several new things such as soldering, Java, CAD work and more. My approach was to prepare before arriving. Upon arriving, my goal was to seek as much knowledge as possible from any one of the experienced mentors (see *acknowledgements*) also involved in the competition. The LCS portion of my internship required IT knowledge that I have ascertained through reading or asking questions throughout the internship.

A. First Robotics Competition

I was told beforehand that the team would write the software for the robot using either C++ or Java. I had already taken an introductory course on C++, so I read through a thin book on programming with Java. I also imagined that I would need to know how to use a 3D printer along with CAD software, so I took a short online course that got me up to speed in SOLIDWORKS and I printed out a camshaft model at school. I decided to use a team based approach (rather than a lecture based approach) to teach students about the robot. Students worked side by side with me to resolve any given issue I was working on, and I explained what we were doing and answered their questions as we worked.

B. Launch Control Systems

My fellow intern and mentor took me on trips to the firing room and showed me how to use schematics and cable running lists, and how to write DVT test procedures. They worked with me until I felt comfortable with the job. I began reading an A+ certification book to expand my IT knowledge so that I can perform better when I return for the summer, and I also have begun an online networking fundamentals course for the same reason.

III. Tasks

A. First Robotics Competition

a. Software Development

I contributed to the software development portion of our project by writing code (using the WPILib library provided by the Worcester Polytechnic Institute) and arranging electrical components so that our software team would be able to debug code despite not having a complete robot. However, our meetings proved to provide an insufficient amount of time for every person to debug code that they had written. Since I was one of only two people who were employed to work on the robot full time, initially much of my time was spent debugging code that other team members wrote but did not have time to test. This was a time-consuming task, and I eventually saw the need to set up a robotics simulator for the group to use from home in order to efficiently utilize the team's limited time. I used SOLIDWORKS and the FRCSim framework provided by the Worcester Polytechnic Institute to configure the Gazebo robotics simulator for the team's use. Figure 1 contains a screenshot from the simulator.

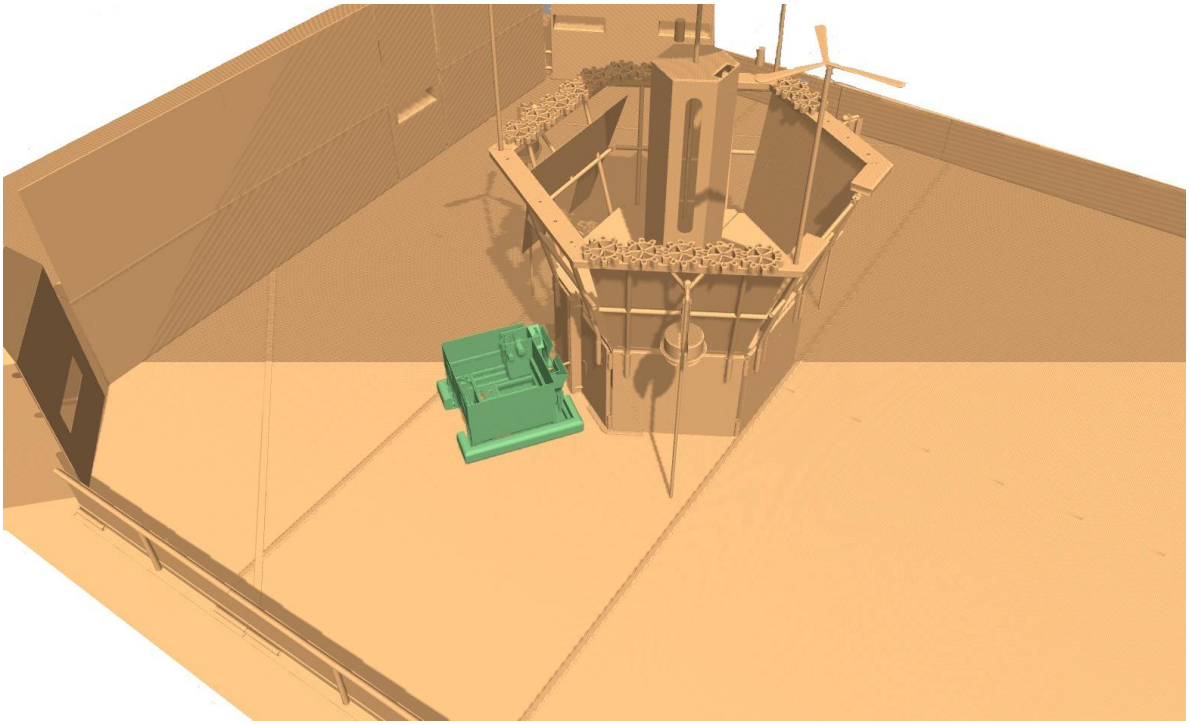

Figure 1: **Our Robot Dropping Off a Gear in the Simulator.** *This is a screenshot from the simulator, where you can see a CAD model of our robot and the 2017 field provided by SOLIDWORKS. The robot (green) can be seen on the field (tan) pretending to deliver a gear to the airship. The gears would enable the rotors (also pictured above) to rotate, which would symbolize that the steam powered airship now had working rotors to use for takeoff.*

b. Electrical work

Since we did not have a completed robot to program initially, for any given meeting I would learn how the electronics needed for the day worked and arrange the electronics so that the software team could write and test code during the meeting. At the various stages of the build phase, I worked with my mentees to add electronics to the robot. This involved crimping, soldering, wire routing to avoid electromagnetic interference, and connections which always resulted in me explaining why wires should be connected where they are. I was on hand at every meeting to ensure that I would be there to fix any electrical issues that arose. I also kept watch to make sure that electrical safety was observed. I attended both of the competitions our team competed in so that I could solve electrical issues that might arise.

c. Miscellaneous

I used SOLIDWORKS to design a bracket to hold an optical encoder used to measure the speed of the flywheel on our shooter. It was 3D printed using a Polyjet printer in the machine shop. In the process I became better at SOLIDWORKS and learned about prototyping.

B. Launch Control Systems

a. Design Verification Tests

I made significant contributions to the DVT test procedures for a network switch and a firewall. In order to do this task, I read through manuals and online examples provided by the equipment manufacturer and explored the terminal menu to learn how to demonstrate each requirement. I also created an organized document that included the test procedures.

b. Running Cable

I helped cut and run almost two miles of cable. I also helped label cables in Firing Rooms 2 and 3, which required analyzing and updating the appropriate cable running lists.

IV. Conclusion

This internship has provided me the opportunity to learn about robot control systems, robotic simulation, Java programming, soldering, crimping, 3D printing, and networking. This experience has given me a foundation for a career in robotics, network engineering and cyber security.

Acknowledgements

I have had terrific colleagues throughout the course of this internship. For his genuine interest in making me a better engineer, I would like to first thank Kelvin Ruiz. I would also like to thank everyone involved with the First Robotics Competition who helped make it a success: Andrew Bradley, Evan Bell, Gregory Clements, Jonathan Nogaj, Joshua Steinrock, Emily Forrester, Christian Morrin, Jonathan Serrano, Meriel Stein, Stephen Aument, Michael Lane, Kelvin Ruiz, Christopher Watts, Kristy Quaranto, Samantha Testa, Todd Steinrock, Kit Gerheart, Nathan Pell, and David Formanek.

References

WPILib, Worcester Polytechnic Institute
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